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MRI REPORT

APPLICATION OF AEROSPACE-GENERATED
TECHNOLOGY TO WATER POLLUTION AND
OTHER PUBLIC SECTOR PROBLEMS

QUARTERLY REPORT NO. 3
1 December 1968 - 28 February 1969

Contract No. NST 26-002-083

MRI Project No. 3217-E(B,C)

For

National Aeronautics and Space Administration
Office of Technology Utilization
Technology Utilization Division
Washington, D. C. 20546

APPLICATION OF AEROSPACE-GENERATED
TECHNOLOGY TO WATER POLLUTION AND
OTHER PUBLIC SECTOR PROBLEMS

by

David Bendersky
Andrew J. Winfrey
Edward T. Fago

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PREFACE

This report covers the activities, during the third quarter, on two tasks being conducted under NASA Contract No. NSR 28-002-083. These two tasks are the application of aerospace technology to (1) water pollution control problems, and (2) other selected public sector problems.

This contract is under the technical direction of Roy Bivins, NASA Technology Utilization Division, Washington, D. C. At Midwest Research Institute this project is under the management of Paul C. Constant, Jr., Assistant Director of the Engineering Sciences Division, and Manager, Technology Utilization. The project leader is David Bendersky, Principal Engineer. Andrew J. Winfrey, Associate Environmental Engineer, and Edward T. Fago, Senior Engineer, contributed to the work reported herein.

Approved for:

MIDWEST RESEARCH INSTITUTE

A handwritten signature in cursive script, reading "Harold L. Stout". The signature is written in dark ink and is positioned above the printed name and title.

Harold L. Stout, Director
Engineering Sciences Division

14 March 1969

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I. INTRODUCTION

NASA Contract No. NSR 26-002-083 calls for Midwest Research Institute's Biomedical Applications Team to conduct a program aimed at the transfer of applicable aerospace technology to secondary applications. Two tasks call for the MRI Biomedical Applications Team to:

1. Conduct a planning study to provide a framework for matching aerospace technology to needs and problems in the area of water pollution. Based on the results of the planning study, a minimum of 12 specific problems in the area of water pollution are to be selected and the applicability of aerospace-generated technology as potential solutions to each of these problems is to be determined.
2. Provide five evaluation reports together with retrospective searches for selected public sector problems which will be aided by the application of aerospace-generated technology.

II. ACTIVITIES ON WATER POLLUTION PROBLEMS

A meeting was held at the Federal Water Pollution Control Administration (FWPCA) in Washington, D. C., on 19 December 1968. The following persons attended this meeting: Drs. A. F. Forziati and C. C. Harlin, FWPCA; R. Bivins, NASA-TUD; D. Bendersky and A. Winfrey, MRI. Mr. Bivins presented the overall objectives of the NASA Technology Utilization Program and described the specific objectives of the NASA contract with MRI. Messrs. Bendersky and Winfrey described the procedures used to determine the applicability of aerospace technology to secondary applications. It was requested that the FWPCA submit a list of water pollution problems from which 12 problems could be selected for processing.

Twenty-two problems, given in the Appendix, were received from the FWPCA on 17 February 1969. An initial screening of these problems indicated that there is a good possibility that there is aerospace technology which may be applicable to Problems Nos. WP-3, WP-5, WP-7 and WP-8. Computerized searches of the aerospace literature related to these four problems have been initiated. There may also be aerospace technology applicable to Problems Nos. WP-4, WP-6, WP-9, WP-10, WP-11, WP-12, WP-15, WP-16, WP-17 and WP-19. It is recommended that preliminary literature searches be conducted on these latter 10 problems. This recommendation is under consideration at the NASA-TU Division.

III. ACTIVITIES ON PUBLIC SECTOR PROBLEMS

In Quarterly Report No. 2, it was proposed that the effort on Task No. 2, public sector problems which may be aided by the application of aerospace technology, be devoted to the area of weather research. On 24 February, Mr. Bivins, NASA-TU Division, notified Mr. Bendersky, MRI Biomedical Applications Team, that this proposal has been accepted by NASA. Problems in weather research are to be submitted by the Federal Bureau of Reclamation, Denver, Colorado. The MRI Biomedical Applications Team is to select six of these problems for processing.

IV. PLANS FOR THE NEXT QUARTER

1. Searches for aerospace technology which may be applied to the solution of water pollution Problems Nos. WP-3, WP-5, WP-7 and WP-8 will be conducted. The search results will be analyzed and reported.

2. Upon receipt of approval from NASA-TUD, searches for applicable aerospace technology will be conducted on eight additional water pollution problems.

3. Six problems in weather research will be selected from the list of problems to be submitted by the Federal Bureau of Reclamation. Searches for applicable aerospace technology will be conducted.

APPENDIX

WATER POLLUTION PROBLEMS SUBMITTED BY THE FWPCA

"EFFECTS OF OIL SPILL CONTROL ADDITIVES"

PROBLEM NO. WP-1

WHAT IS NEEDED:

Ecologic effects produced by the use of each specific dispersant, adsorbent, sinking agent, gelling agent, etc., considered for use in cleanup of oil spills.

BACKGROUND:

Serious damage may be caused by indiscriminate use of some of these substances.

Safe materials, if any, will be recommended for stockpiling, or contingency plans will be based on other means of cleanup.

SUBMITTED BY: FWPCA

Name: A. F. Forziati

Title: Acting Assistant Director of Physical Sciences

Organization: Division of Water Quality Research, R&D

Date: 2/4/69

"OIL POLLUTION MONITORING BY IMPROVED AND NEW METHODS"

PROBLEM NO. WP-2

WHAT IS NEEDED:

Methods for identification and quantitation of oil pollutants in coast and estuary waters need to be developed and new methods correlated so as to improve "fingerprint" and "sensitivity" capabilities. Infrared and gas chromatography methods need to be improved in sensitivity and specificity for this particular kind of pollution. The analysis of trace compounds and elements inherent in the petroleum products should be further developed and new, substantially more sensitive and more general methods need to be applied (neutron activation analysis and isotope dilution methods).

BACKGROUND:

Monitoring of coastal and estuarine waters for petroleum product pollution is an important part of the FWPCA mission. Surveillance and standards

implementation require continual development and application of better methods is apparent.

As these several methods begin to obtain useful results, they will all be correlated and analyzed via electronic data processing with the goal of specification for any sample of its original geographic source, its industrial processing history, and its probable ecological behavior in the given case. This information would be available throughout the U. S. A. and, with the cooperation of oil producing and manufacturing nations, throughout the world. Since these methods are particularly amenable to automation, further projects leading to automation and use as Standard Procedures would be proposed.

SUBMITTED BY: FWPCA

Name: A. F. Forziati

Title: Acting Assistant Director of Physical Sciences

Organization: Division of Water Quality Research, R&D

Date: 2/5/69

"AERIAL SURVEILLANCE OF WATER QUALITY"

PROBLEM NO. WP-3

WHAT IS NEEDED:

Development of methods, techniques and equipment to determine relative water quality, and to detect changes due to pollution, pollution sources, and character of pollutants by aerial observations, surveys and photographs.

BACKGROUND:

Water quality and pollution determinations by aerial surveys offer one of the quickest and least costly methods known at this time. It will be of considerable value to the water pollution control program if this method can be developed for regular use.

Results will be used in developing Regional surveys, investigations and surveillance activities. Information will be made available to state water pollution control agencies.

SUBMITTED BY: FWPCA

Name: A. F. Forziati

Title: Acting Assistant Director of Physical Sciences

Organization: Division of Water Quality Research, R&D

Date: 2/4/69

"TASTE AND ODOR CAUSES AND CONTROLS"

PROBLEM NO. WP-4

WHAT IS NEEDED:

What causes taste and odors in water; and how can these tastes and odors be prevented?

BACKGROUND:

In Water Quality Standards we have taste and odor criteria. We need to know the cause and prevention so we can suggest treatment and operation that will help control the problem.

Information obtained will be used to prescribe needed treatment and control. The controls might pertain to waste handling and/or reservoir controls in order to meet Water Quality Standards criteria.

SUBMITTED BY: FWPCA

Name: A. F. Forziati

Title: Acting Assistant Director of Physical Sciences

Organization: Division of Water Quality Research, R&D

Date: 2/4/69

"DEVELOP REMOTE SENSING AND/OR MONITORING SYSTEMS
FOR RADIOLOGICAL PARAMETERS"

PROBLEM NO. WP-5

WHAT IS NEEDED:

Design a sensor or monitoring system which will automatically measure and record emissions in streams or impoundments at remote locations with minimal operation and maintenance.

BACKGROUND:

Basic data collection at far distant sampling points, in the Southwest Region, is time consuming and expensive. Present and foreseeable personnel ceilings preclude collection of continuous or highly frequent data, needed to define radiological pollution patterns.

Such units would be employed at remote sampling locations in the Southwest Region.

SUBMITTED BY: FWPCA

Name: A. F. Forziati

Title: Acting Assistant Director of Physical Sciences

Organization: Division of Water Quality Research, R&D

Date: 2/4/69

"NUTRIENT ANALYSES, PHOSPHATE AND AMMONIA"

PROBLEM NO. WP-6

WHAT IS NEEDED:

Development of more sensitive, accurate and satisfactory methods for determination of the nutrients, phosphate and ammonia, in waste and waste receiving waters.

BACKGROUND:

Control of eutrophication requires control of nutrients; control of nutrients requires that determinations of phosphate and ammonia concentrations in waste and waste receiving waters be made accurately.

Results will be used where conditions indicate a requirement in Regional laboratories. The results will also be made available for use by other water pollution control agencies in the Region.

SUBMITTED BY: FWPCA

Name: A. F. Forziati

Title: Acting Assistant Director of Physical Sciences

Organization: Division of Water Quality Research, R&D

Date: 2/4/69

"SIMPLIFY DETERMINATION OF RADIUM 226"

PROBLEM NO. WP-7

WHAT IS NEEDED:

A method as accurate or more so than the one in use, but which does not require the consumption of costly material, such as platinum.

BACKGROUND:

Potential pollution is very great in the Colorado River Basin by wastes from uranium and other radioactive metal mining and milling operations. Surveillance requires frequent determinations of radium 226. Decreasing the cost of these determinations is essential.

The simplified determination will be used in Regional laboratory determinations, and will be made available to all FWPCA laboratories and to all water pollution control agencies where radioactive wastes are, or may be, a problem.

SUBMITTED BY: FWPCA

Name: A. F. Forziati

Title: Acting Assistant Director of Physical Sciences

Organization: Division of Water Quality Research, R&D

Date: 2/4/69

"THE UTILITY OF LASERS FOR LABORATORY ANALYTICAL EQUIPMENT"

PROBLEM NO. WP-8

WHAT IS NEEDED:

New and improved laboratory analytical equipment for detection and quantifying of pollutants in water samples.

BACKGROUND:

New laboratory equipment is needed to shorten the time interval between obtaining a sample and reporting results.

Results will be used in the development of more modern analytical equipment.

SUBMITTED BY: FWPCA

Name: A. F. Forziati

Title: Acting Assistant Director of Physical Sciences

Organization: Division of Water Quality Research, R&D

Date: 2/4/69

"CORRELATION OF I. R. IMAGERY WITH OTHER WATER QUALITY PARAMETERS"

PROBLEM NO. WP-9

WHAT IS NEEDED:

Can remote sensing be used to determine the concentration of dissolved oxygen, salinity, nutrients, coliform organisms and/or other parameters in saline and fresh waters?

BACKGROUND:

Result would be a great saving in time and money involved in sampling and pollution surveillance.

Can be used in studies involving predictive models; routine surveillance; enforcement actions; emergency conditions.

SUBMITTED BY: FWPCA

Name: A. F. Forziati

Title: Acting Assistant Director of Physical Sciences

Organization: Division of Water Quality Research, R&D

Date: 2/5/69

"UTILITY OF ACTIVATION ANALYSES FOR THE MEASUREMENT OF POLLUTANTS"

PROBLEM NO. WP-10

WHAT IS NEEDED:

Large expenditures have been made for laboratory activation analyses equipment in connection with our lunar probe program. This instrumentation may

have some utility in the field of water pollution control and its utility should be investigated.

BACKGROUND:

As investigation of the utility of activation analyses for the measurement of pollutants is needed for the development of new and improved laboratory analytical equipment.

Results can be used in the development of new laboratory equipment which will precisely measure quality and quantity of pollutants in water samples.

SUBMITTED BY: FWPCA

Name: A. F. Forziati

Title: Acting Assistant Director of Physical Sciences

Organization: Division of Water Quality Research, R&D

Date: 2/5/69

"IMPROVED MEASUREMENT OF BOD PARAMETERS"

PROBLEM NO. WP-11

WHAT IS NEEDED:

(a) Better means of evaluating waste treatment plant efficiency in modifying the BOD characteristics of the waste, including total amounts and rate constants for various components and lag factors as may be necessary to adequate characterization. Development of standard methods useful for plant control and surveillance. (b) Extension of the above methods to the effluent plus-receiving-water mixtures, taking into account stream or marine environment, so that a standard method for reliable modelling and prediction of effects in the receiving water can be provided.

BACKGROUND:

The five-day BOD test is totally inadequate for program needs, and a method for routine determination of rate constants and BOD's is essential. The method should ideally be responsive to conditions of the receiving water environment. The validity of mathematical modelling results is at stake.

1. In tests to characterize waste waters, treated effluents, and natural waters, either clean or polluted, and to evaluate efficiency of biological waste treatment processes. 2. To collect data required as input for

mathematical models, which are used in planning for plant design and all phases of water quality management.

SUBMITTED BY: FWPCA

Name: Louis Swaby

Title: Technical Assistant

Organization: Division of Water Quality Research, R&D

Date: 2/5/69

"THE ORGANIC CONTENT OF EUTROPHIC LAKE SEDIMENTS IN ITS
CONTRIBUTION TO HETEROTROPHIC ALGAL METABOLISM"

PROBLEM NO. WP-12

WHAT IS NEEDED:

What organic compounds are contained in the sediments of a typically eutrophic lake? Are any of these organic compounds stimulatory to algal growth? Are blue-green algae capable of using these organic compounds as an energy source for growth in the dark?

BACKGROUND:

Several investigators have theorized that the growth of blue-green algae in lakes is initiated at the sediment-water interface where sunlight is either absent or limited. If this is so, it follows that these algae must be employing an energy source, other than sunlight, to carry out their metabolic functions. In the case of limited light, the sediments may be providing the algae with essential growth factors.

The results will add to the fundamental knowledge of the factors affecting blue-green algal growth and perhaps to the understanding of the cause and control of blue-green algal blooms.

SUBMITTED BY: FWPCA

Name: Hend Gorchev

Title: Technical Assistant

Organization: Division of Water Quality Research, R&D

Date: 2/4/69

"NUTRIENT CYCLING AND GROWTH OF PHOTOSYNTHETIC ORGANISMS
IN COASTAL WATERS"

PROBLEM NO. WP-13

WHAT IS NEEDED:

Establish the dependence of photosynthetic organisms on combined effects of salinity, temperature, mixing and nutrients, especially nutrients cycled between deposited materials and overlying water and nutrients cycled between nearshore waters and deep offshore waters.

BACKGROUND:

The growth of photosynthetic organisms represents one of the most delicate balances between high value water quality and polluted water, some degree of growth being necessary for harvestable production and too much producing noxious conditions. The oxygen production and demand functions also contribute to the diurnal fluctuation of the dissolved oxygen balance, which can be critical for some estuaries. To prevent new problems and to solve those in existence, it is necessary to evaluate what degree of growth control can be achieved with sediment removal, treatment of discrete waste streams, diversion of waste streams and coastal currents.

Used in and to improve existing assessment techniques available to water pollution control authorities. This will improve their ability to decide on acceptability of waste discharge practices and to recommend surveillance and control programs.

SUBMITTED BY: FWPCA

Name: Hend Gorchev

Title: Technical Assistant

Organization: Division of Water Quality Research, R&D

Date: 2/4/69

"MEASUREMENTS OF CHEMICAL, BACTERIAL, AND BIOLOGICAL
INDICES OF WATER QUALITY"

PROBLEM NO. WP-14

WHAT IS NEEDED:

Field instrumentation (both portable and fixed) is needed which can rapidly measure (preferably automatically) the following indices: bacterial

density (esp. coliforms), phytoplankton (density, and concentrations of organic nitrogen, ammonia nitrogen, nitrate nitrogen, organic phosphorus, inorganic phosphorus, trace organics, biodegradable organic material, total solids, suspended solids, trace metals, cyanide, and other toxic materials.

BACKGROUND:

The indices listed must be measured frequently in order to evaluate compliance with water quality standards and wastes being discharged to waterways.

SUBMITTED BY: FWPCA
Name: Louis Swaby
Title: Technical Assistant
Organization: Division of Water Quality Research, R&D
Date: 2/4/69

"TASTES AND ODORS"

PROBLEM NO. WP-15

WHAT IS NEEDED:

Need specific analytical techniques to judge taste and odors.

BACKGROUND:

Tastes and odors remain the most vexing problem of water treatment plant operation in public water supplies.

The techniques would be used in plant design and plant operation.

SUBMITTED BY: FWPCA
Name: A. F. Forziati
Title: Acting Assistant Director of Physical Sciences
Organization: Division of Water Quality Research, R&D
Date: 2/4/69

"RELIABLE WATER QUALITY MONITORING EQUIPMENT TO OBTAIN
NEEDED BASELINE DATA IN REMOTE AREAS"

PROBLEM NO. WP-16

WHAT IS NEEDED:

Development of a self-contained monitor unit which will provide reliable service and dependable accurate data without extensive service and frequent repairs.

BACKGROUND:

Due to the large physical area of the region's responsibility and the difficulties of travel at some seasons of the year, it is imperative that a means be developed to provide for the automatic collection of water quality data for certain parameters in order to fulfill our responsibility for maintenance of a surveillance program. Present monitor units are subject to frequent hydraulic and mechanical problems and require routine servicing at a too frequent rate to permit their extensive use without a considerable manpower force for service and repair.

A reliable monitor unit would facilitate the collection of basic data at a sufficient number of locations adequate to develop a suitable data base for the major streams of the basin area. With a reliable monitor unit, the regional surveillance activities could be greatly increased without a substantial increase in manpower support for monitor service. Such an instrument would also be of value throughout the country in reducing support efforts required for surveillance activities.

SUBMITTED BY: FWPCA

Name: A. F. Forziati

Title: Acting Assistant Director of Physical Sciences

Organization: Division of Water Quality Research, R&D

Date: 2/5/69

"IDENTIFICATION OF ALGAL BLOOMS AND AQUATIC PLANT GROWTHS
IN LAKES BY MEANS OF AIRBORNE REMOTE SENSING TECHNIQUES"

PROBLEM NO. WP-17

WHAT IS NEEDED:

Instrumentation should be developed which, when positioned aurally by aircraft or satellite, possesses the capability of sensing the presence of algal blooms or dense growths of emergent or submergent higher aquatics. This instrumentation should be able to at least distinguish among major types of algae, i.e., diatoms, greens, and blue-greens, and, for maximum usefulness, should be capable of "seeing" into the water to some depth as well as merely sensing strictly surface phenomena.

BACKGROUND:

These techniques would make possible rapid, convenient, and nearly continuous surveillance of entire lake regions for the purpose of early detection and continued monitoring of eutrophication processes as indicated by the appearance of algal blooms. The techniques would also be particularly applicable to the Great Lakes and other large bodies where eutrophication rates are non-uniform and where synoptic observations are very difficult to obtain.

Such instrumentation, if developed, could be used by the National Eutrophication Research Program to develop a monitoring routine in various lake areas and on the Great Lakes. If successful satellite-borne equipment should become available, surveillance on a world-wide scale, including oceans as well as lakes, could be carried out. Such observations would be valuable in the study of long-term eutrophication trends and in the identification of problem areas related to pollution by aquatic plant growth stimulants.

SUBMITTED BY: FWPCA

Name: A. F. Forziati

Title: Acting Assistant Director of Physical Sciences

Organization: Division of Water Quality Research, R&D

Date: 2/5/69

"DEVELOP REMOTE SENSING AND/OR MONITORING SYSTEMS FOR OIL"

PROBLEM NO. WP-18

WHAT IS NEEDED:

Design a sensor or monitoring system which will automatically measure and record concentration of oil in streams or impoundments at remote locations with minimal operation and maintenance.

BACKGROUND:

Basic data collection at far distant sampling points, in the Southwest Region, is time-consuming and expensive. Present and foreseeable personnel ceilings preclude collection of continuous or highly frequent data to define oil pollution patterns.

Such units would be employed at remote sampling locations in the Southwest Region.

SUBMITTED BY: FWPCA

Name: A. F. Forziati

Title: Acting Assistant Director of Physical Sciences

Organization: Division of Water Quality Research, R&D

Date: 2/4/69

"THE USE OF LASERS FOR AIRBORNE SURVEILLANCE"

PROBLEM NO. WP-19

WHAT IS NEEDED:

Whether or not gas, crystalline, or liquid lasers can be utilized in the airborne water quality surveillance of bays and estuaries.

BACKGROUND:

Current technology in the area of water quality surveillance of bays and estuaries results in programs which are time-consuming and expensive. New and improved water quality surveillance methodology that will produce instantaneous results is needed.

Results from this project will be used for the development of well-managed water quality surveillance and monitoring systems in this nation's bays and estuaries.

SUBMITTED BY: FWPCA

Name: A. F. Forziati

Title: Acting Assistant Director of Physical Sciences

Organization: Division of Water Quality Research, R&D

Date: 2/4/69

"EFFECTS OF ALGAL BLOOMS IN AN ESTUARY"

PROBLEM NO. WP-20

WHAT IS NEEDED:

1. Does the decomposition of algal blooms cause a significant dissolved oxygen depletion in the estuaries of the Middle Atlantic Region? 2. Are the growths of algal blooms dependent on the nutrient concentrations in waste water discharges: If so, what are the threshold concentrations which will result in excessive algal growths? 3. Will the reduction of the nutrients in waste water discharges to the estuaries result in a significant reduction in algal blooms with a subsequent improvement in water quality? 4. Are there any ecological benefits to be derived from the enrichment of an estuary by increased nutrient enrichment?

BACKGROUND:

With current technology, the removal of nutrients from waste waters is an expensive process. Before large sums of money are expended to expand treatment facilities to include nutrient removal, it is important to be able to predict accurately the benefit, in terms of water quality enhancement, which may be realized from such removal. Also, it is possible in some estuarine areas increased enrichment may yield considerable social and economic benefits, i.e., increase in fish population and harvesting of algae for food.

The results will be used to evaluate the benefits to water quality enhancement to be derived from removing nutrients from estuarine waste water discharges. Specific applications would be in the Potomac and James River Estuaries.

SUBMITTED BY: FWPCA

Name: Hend Gorchev

Title: Technical Assistant

Organization: Division of Water Quality Research

Date: 2/4/69

"THE ROLE OF ATMOSPHERIC PLANT NUTRIENTS IN THE
EUTROPHICATION OF NATURAL WATER"

PROBLEM NO. WP-21

WHAT IS NEEDED:

What concentrations of essential plant nutrients are contained in rain falling over agricultural and industrial areas? What is the contribution of these nutrients to the algal and aquatic plant growth potential of natural water?

BACKGROUND:

There is scattered information in the literature concerning plant nutrients contained in rainfall. For example, in Sweden it has been reported that rainwater contained 0.03 mg/l P and 0.2 mg/l total N. When it is considered that the Report of the Committee on Water Quality Criteria recommends that phosphorus levels in streams entering lakes and reservoirs should not exceed levels of 0.05 mg/l, the nutrients contributed by rainwater could be extremely important in respect to eutrophication of our natural waters.

The results will aid in predicting the contribution of plant nutrients from the atmosphere in a particular geographical area depending upon the annual precipitation and allow us to more realistically determine to what levels nutrients must be reduced to prevent eutrophication of our natural waters.

SUBMITTED BY: FWPCA

Name: Hend Gorchev

Title: Technical Assistant

Organization: Division of Water Quality Research, R&D

Date: 2/4/69

"PLANKTON BLOOM PREDICTIONS"

PROBLEM NO. WP-22

WHAT IS NEEDED:

Determination of the onset or triggering of estuarine or oceanic plankton blooms from heat budget terms such as incoming solar radiation, back radiation, etc.

BACKGROUND:

To predict, hence be in a position to control, the conditions required to initiate the genesis of large amounts of plankton from a knowledge of easily-measured parameters.

As a possible indicator of conditions liable to initiate eutrophic conditions.

SUBMITTED BY: FWPCA

Name: Hend Gorchev

Title: Technical Assistant

Organization: Division of Water Quality Research, R&D

Date: 2/4/69

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